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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte ERROL T. RYAN,
PAUL R. BESSER,
SIMON SIU-SING CHAN,
ROBERT J. CHIU,
MEHRDAD MAHANPOUR,
and MINH VAN NGO

Appeal 2008-2375
Application 10/791,096
Technology Center 2800

Decided: June 27, 2008

Before EDWARD C. KIMLIN, CHARLES F. WARREN, and
JEFFREY T. SMITH, *Administrative Patent Judges*.

KIMLIN, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal from the final rejection of claims 1, 2, 4-7, 9-12,
14-17, 19, and 20. Claim 1 is illustrative:

1. A method of forming an integrated circuit comprising:
 - providing a semiconductor substrate;
 - forming a gate dielectric on the semiconductor substrate;
 - forming a gate on the gate dielectric;
 - forming source/drain junctions in the semiconductor substrate;
 - forming a silicide on the source/drain junctions and on the gate within a thermal budget having a temperature dependent upon a silicide metal;
 - depositing an interlayer dielectric having contact holes therein above the semiconductor substrate;
 - forming contact liners in the contact holes within the thermal budget for forming the silicide; and
 - forming contacts in the contact holes over the contact liners, whereby the contact liners are formed of a nitride of the material of the contacts.

The Examiner relies upon the following references as evidence of obviousness:

Lim	US 2004/0115929 A1	Jun. 17, 2004
Tseng	US 2005/0035460 A1	Feb. 17, 2005
Chang	6,858,506 B2	Feb. 22, 2005

Wolf and Tauber, *Silicon Processing for the VLSI ERA*, Vol. 1, Second Edition, 727 (2000).

Appellants' claimed invention is directed to a method of forming an integrated circuit comprising, inter alia, forming a silicide on the source/drain junctions within a thermal budget having a temperature based on the silicide metal, and forming contact liners in contact holes within an

interlayer dielectric layer within the thermal budget for forming the silicide.

The appealed claims stand rejected under 35 U.S.C. § 103(a) as follows:

- (a) claims 1, 2, and 4-7 over Chang in view of Lim,
- (b) claim 9 over Chang in view of Lim and Tseng,
- (c) claims 11, 12, 15-17, and 20 over Chang in view of Ling and Tseng,
- (d) claim 10 over Chang in view of Lim, Tseng and Wolf,
- (e) claims 14 and 19 over Change in view of Lim, Tseng and Wolf.

We have thoroughly reviewed each of Appellants' arguments for patentability. However, we find ourselves in complete agreement with the Examiner's reasoned analysis and application of the prior art, as well as her cogent and thorough disposition of the arguments raised by Appellants. Accordingly, we will adopt the Examiner's reasoning as our own in sustaining the rejections of record, and we add the following for emphasis only.

Chang, like Appellants, discloses a method of forming an integrated circuit comprising forming a gate dielectric on a semiconductor substrate, forming a gate on the gate dielectric, forming source/drain junctions in the semiconductor substrate, and forming a nickel silicide on the junctions at a temperature in the range of about 400-800°C. Since Appellants' Specification discloses that the thermal budget for forming the nickel silicide is in the range of about 400-450°C, the Examiner has properly concluded that it would have been obvious for one with ordinary skill in the art to form the silicide layer of Chang within the claimed thermal budget.

Although Chang discloses that the silicide layer may be formed at temperatures outside, as well as within, Appellants' disclosed range, we find no merit in Appellants' argument that such is a teaching away from the claimed thermal budget. One of ordinary skill in the art would have found it obvious to operate at all the temperatures within the range disclosed by Chang. Furthermore, we find that it would have been obvious for one with ordinary skill in the art to resort to routine experimentation to determine the optimum thermal budget for forming the claimed silicide and contact liners. Contrary to Appellants' argument regarding the criticality of the disclosed thermal budget, Appellants have proffered no objective evidence that the asserted criticality would have been truly unexpected to one of ordinary skill in the art. *In re Merck & Co.*, 800 F.2d 1091, 1099 (Fed. Cir. 1986); *In re Klosak*, 455 F.2d 1077, 1080 (CCPA 1972). Indeed, Appellants acknowledge the following at page 3 of the Reply Brief:

As well known to those skilled in the art and previously partially explained, the thermal budget defines the total amount of thermal energy transferred to the wafer during a given elevated temperature operation which is proportional to the temperature and duration of the process such that a low thermal budget is possible even at a very high temperature if the time of the process is short. For semiconductor processes, the thermal budget is generally given in units of °C. Exceeding the thermal budget will result in a defective or inoperative integrated circuit. Exceeding a temperature for a short enough time would not affect the integrated circuit.

Consequently, Appellants' acknowledgement underscores that the claimed thermal budget was a known result effective variable for making a satisfactory integrated circuit, and it is well settled that the determination of

the optimum value of a result effective variable is a matter of obviousness for one of ordinary skill in the art. *In re Boesch*, 617 F.2d 272, 276 (CCPA 1980).

Concerning the claimed step of depositing an interlayer dielectric having contact holes therein above the semiconductor substrate, Appellants have not rebutted the Examiner's reasoning that Lim supports the obviousness of forming such an interlayer dielectric above the semiconductor substrate of Chang by evidencing that it "well known in the art of semiconductor processing as a means of providing and accessing electrical signals to and from devices on an integrated circuit" (Ans. 17, second sentence). Appellants' argument that Chang does not disclose such an interlayer dielectric, and Lim does not disclose the formation of a silicide, is an ineffective attack on the references individually that fails to address the thrust of the Examiner's rejection based on the collective teachings of Chang and Lim.

Regarding the claimed ultra-thin thickness of the nickel silicide, we fully concur with the Examiner that Tseng evidences the obviousness of forming an ultra-thin nickel silicide of 50 Angstroms in order to obtain a semiconductor device with reduced contact resistance. We find no merit in Appellants' argument that Tseng's disclosure of a preference for a silicide thickness between about 50 Angstroms and 350 Angstroms is a teaching away of ultra-thin silicides, in general, and silicides having a thickness of about 50 Angstroms, in particular. Furthermore, the Examiner correctly notes that the claims on appeal do not recite a silicide thickness of 50 Angstroms, and Appellants' Specification fails to define a particular thickness for the claimed "ultra-thin thickness." The disclosure at page 7 of

Appellants' Specification, cited by Appellants, defines an ultra-uniform silicide as having no variations in thickness greater than about 3 percent of the overall thickness and that it is **preferable** to achieve an ultra-thin thickness of not more than 50 Angstroms. Such a stated preference does not define a value for the claimed ultra-thin thickness and, furthermore, such a preference would seem to allay any suggestion of the criticality for the unspecified ultra-thin thickness.

As a final point, we note that Appellants base no argument upon objective evidence of nonobviousness, such as unexpected results. Assertions of preferences or, for that matter, criticality in the Specification without supporting objective data is no substitute for factual evidence of unexpected results.

In conclusion, based on the foregoing and the reasons well stated by the Examiner, the Examiner's decision rejecting the appealed claims is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED

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